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Measurement of job satisfaction using fuzzy sets

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Abstract

The measurement of job satisfaction is carried out using the set of variables of some criterions defined by the experts. This measurement is basically based on linguistic evaluations of the variables. In the paper these linguistic values are represented by fuzzy sets as preference levels. A fuzzy set theory was combined with conjoint analysis and used for measurement of the job satisfaction of hotel employees. The algorithm for solving of fuzzy job satisfaction has been designed. The attributes for evaluation of job satisfaction are determined and employees' opinions were recorded in the form of preference degrees. The statistical data describing satisfaction levels of hotel employees are collected. The membership degrees for each attribute are determined and using a similarity measure the closest of opinions of the employees and experts' are determined. These closest degrees are ranked, and the evaluation of job satisfaction has been performed.

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Keywords: Job satisfaction; fuzzy conjoint model; similarity degree.

1. Introduction

Recently a set of research works have been done on job satisfaction. Some of these studies use percentage and mean values for the analysis. Likert scale is used to study and evaluate job satisfaction of library staff at the University of North California[3]. The paper[4] uses Likert scale for evaluation of job satisfaction in South African University. The paper[5] uses five and seven points Likert scale to evaluate job satisfaction by analysing the measures of statistical mean, standard deviation and correlation. In[6] gives analyse of job satisfaction of college teachers. The

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use of artificial intelligence techniques in assessment and evaluation of performances of teachers has been considered in research papers[7,8] .

The analysis of job satisfaction of hotel employees is important in service business. Hotel enterprise is as an important part of hospitality. The level of job satisfaction of hotel employees has influence to their behaviour, and then has influence to the customer's satisfaction directly. Consequently the job satisfaction of employees affects the efficiency of the hotels. The satisfaction of employees increases their retention, productivity, a higher level of service quality[9]. There are few studies on job satisfaction of the hotel employees. The relationship between demographic characteristics of hotel employees and job satisfaction has been examined in[10,11,12]. These researches are basically based on statistical analysis.

Fuzzy set theory provides an excellent framework for describing imprecise meaning of preferences and their subjective nature. Recently a set of research works have been done for evaluation of job satisfaction using fuzzy set theory. The paper[13] used fuzzy set theory for evaluation of job satisfaction of academic staff. Fuzzy sets theory is also used for evaluation of students' perceptions on computer algebra[14], teaching quality[15], teachers' beliefs[16], credit card services[17]. In these researches, different approaches have been used for solution of job satisfaction problem.

The paper is organized as follows. Sec.2 gives descriptions of the fuzzy sets and fuzzy conjoint analysis. The conjoint model used for evaluation of job satisfaction of hotel employees is presented. Sec. 3 describes the experimental results. The flowchart of the algorithm used for evaluation of job satisfaction of hotel employees using conjoint analysis is presented. Sec. 4 includes comparative results of existing methods. Finally, in Sec.5 the conclusions are presented.

2. Fuzzy conjoint model for measurement of job satisfaction

Conjoint analysis was used to study preferred levels of individuals and relative importance of the multiple attributes of market goods[18]. Individuals can evaluate the multi- attributes using responses that are approximately interval in a measurement level. The requirements of one group may have a conflict with the requirements of other groups and evaluation these factors among diverse customer needs is critical. In our case, a multivariate technique is used to demonstrate how respondents develop preferences. Conjoint analysis allows to estimate the relative importance of selected attributes. Respondents express their preferences by providing the importance of the attribute.

The preferences of respondents are basically vague, uncertain and they have a subjective nature based on feeling individuals. Fuzzy set theory provides an excellent framework for describing preferences, their subjective nature. Due to subjective uncertainty, imprecise meaning of preferences, fuzzy set theory was combined with conjoint analysis. The variables used in job satisfaction are linguistic variables and their values are estimated by preferences of individuals. For example: satisfied, very satisfied, unsatisfied etc.

Fuzzy conjoint analysis proposed by Turksen and Willson (1994) is used for the analysis of consumer preferences in marketing[18]. Fuzzy sets are used to represent the values of the attributes evaluated by respondents. The membership degree of element y_j for the linguistic label representing item A is defined as

$$\mu_R(y_j, A) = \sum_{i=1}^{n} \left[\frac{w_i}{\sum w_i} \right] \cdot \mu_{F_i}(x_j, A) \tag{1}$$

where w_i is a score of linguistic value given by i-th respondent, $w_i \Big/ \sum w_i$ is the weight that represent level of satisfaction, $\mu_{F_i}(x_j, A)$ is the membership degree for respondent j for item A according linguistic label x_j=1,2,…,n, n is a number of linguistic term, A is an item/a question.

The membership degree represents the fuzzy set of response of the respondent. This fuzzy set is compared with fuzzy set defined by expert. The comparison is done using fuzzy similarity measure which is based on Euclidian distance of two fuzzy sets. The similarity measure is calculated as follows.

$$Sim(R_i(y_j,A),F(x_j,l)) = \frac{1}{\left[1+\sqrt{\sum_{j=1}^{n}(\mu_{R_i}(y_j,A)-\mu_F(x_j,l))^2}\right]};\ i=1,..,M,\ j=1,\ldots,N \quad (2)$$

where $R_i(y_j,A)$ is the fuzzy sets determined using the responses of respondents, $F(x_j,l)$ is the standard fuzzy sets determined for linguistic label *l*. M is the number of attributes, N is the number of linguistic terms. The similarity is computed for product m for each of the n possible linguistic terms. The similarity rate ranges from 0 to 1. Here N is the number of members in the linguistic variable vector.

3. Experimental results

In order to ascertain the job satisfaction of employees, we requested to specify their level of satisfaction or dissatisfaction using Likert's 5 point Scale. Each of the questions was evaluated by linguistic terms. In the paper, five linguistic terms with five satisfaction level were created. The scale was represented as follows: Very Satisfied (VS), Satisfied (S), Neutral (N), Dissatisfied (DS) and Very Dissatisfied (VDS). Fuzzy set theory is applied to represent these linguistic variables. The triangular membership functions are used to represent the fuzzy sets. Fig. 1 illustrates an example of the fuzzy sets representing the level of satisfaction. The membership functions of the fuzzy terms are represented by following formula.

$$\mu_A(x)=\begin{cases}\dfrac{x-a_1}{a_2-a_1}r & \text{if } a_1\le x\le a_2\\ \dfrac{a_3-x}{a_3-a_2}r & \text{if } a_2\le x\le a_3\\ 0 & otherwise\end{cases} \quad (3)$$

where a_2 is centre, a_1 is left and a_3 is right sides of triangle.

As mentioned above 20 attributes are applied to the questionnaire. The respondents were selected one of the answers of these variables in each choice. The level of satisfaction of the employees for each question in terms of 5 point Likert's scales is given in Table 1. The numbers of the employees and their percentages are given in the table. The results of answers for item 1 and item 2 are reported below.

- Item 1. Activity: 13% of the employees were very dissatisfied with the activities in the hotels, 13%- dissatisfied, while 42% of the employees were satisfied, 15% - very satisfied and 17% of the employees preferred to be neutral.
- Item 2. Independence: 11% of the employees were very dissatisfied with the way that they are allowed to work independently, 14% of the employees were dissatisfied, while 41% of the employees expressed that they were satisfied, 15%- very satisfied. 19% of the employees were neutral.

Similarly, the results of answers for other attributes could be analysed.

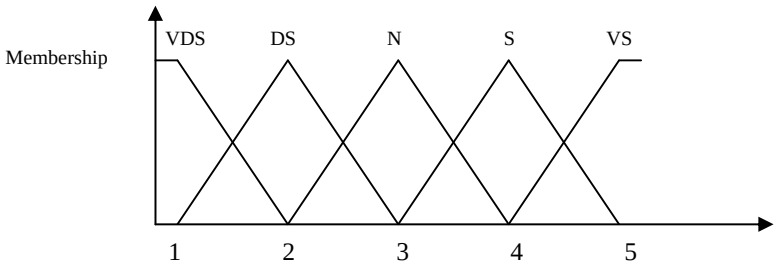

Fig. 1. The fuzzy sets representing the level of satisfaction.

Table 1. Job Satisfaction Level Analysis

Scale	VDS		DS		N		S		VS	
Ques.	Fr.	%	Fr.	%	Fr.	%	Fr.	%	Fr.	%
Item 1	31	13	31	13	44	17	106	42	36	15
Item 2	28	11	35	14	47	19	100	41	38	15
Item 20	23	9	20	8	28	11	91	37	86	35

The input data given in Table 1 were provided to the input of job satisfaction system. Preference levels are determined using linguistic terms ‘very satisfied’, ‘satisfied’, ‘neutral’, ‘dissatisfied’, ‘very dissatisfied’. According to the number of linguistic terms, the universe of fuzzy set is defined as (k= 1, 2, 3, 4, 5).

The five membership functions are defined using following expressions. “Very Satisfied” is defined as $F_1 = \left\{ \frac{1}{1}, \frac{0.6}{2}, \frac{0.2}{3}, \frac{0}{4}, \frac{0}{5} \right\}$, “Satisfied”- $F_2 = \left\{ \frac{0.6}{1}, \frac{1}{2}, \frac{0.6}{3}, \frac{0.2}{4}, \frac{0}{5} \right\}$, “Neutral”- $F_3 = \left\{ \frac{0.2}{1}, \frac{0.6}{2}, \frac{1}{3}, \frac{0.6}{4}, \frac{0.2}{5} \right\}$, “Dissatisfied”- $F_4 = \left\{ \frac{0}{1}, \frac{0.2}{2}, \frac{0.6}{3}, \frac{1}{4}, \frac{0.6}{5} \right\}$, “Very Dissatisfied”- $F_5 = \left\{ \frac{0}{1}, \frac{0}{2}, \frac{0.2}{3}, \frac{0.6}{4}, \frac{1}{5} \right\}$

In the second step using attributes and preference levels the questionnaire for job satisfaction problem is constructed and distributed among hotel employees. Hotel employees’ opinions for each attribute in the questionnaire are collected. 248 questionnaires are collected from the employees of different hotels of North Cyprus. The collected questionnaires are analyzed using employees’ opinions regarding to a selected linguistic variable. Table 1 demonstrates the results of the analysis. For example, in the table for the first item, 31 employees had chosen very dissatisfied (13% of employees), 31 (13%) dissatisfied, 44(14%) neutral, 106 (42%) satisfied, 36 (15%) very satisfied. Analysis has been performed for each attribute of questionnaires. After analysis of questionnaire results, in third step, the satisfaction degree levels for each attribute is calculated using fuzzy CA model of Turksen and Willson’s formula (1). The operations have been performed by computing weight and correspondingly the membership degree (R) for respondent j for the item *A* according linguistic label. Table 2 depicts the values of membership functions. After calculating membership degrees in the fourth step the similarity degree values between employees’ opinions and experts’ opinions are calculated. This operation has been done by computing similarity degree between fuzzy sets *R* and *F* using formula (2). In last fifth step, the maximum amount of similarity degrees for each state is determined. Similarity degree demonstrates the maximum closeness of experts and customers’ opinions to each other. Table 3 demonstrates the similarity degrees between fuzzy sets *F* and *R*.

Table 2. The Values of membership degree of fuzzy sets *R*.

	F_1	F_2	F_3	F_4	F_5
R1	0.1250	0.1250	0.1774	0.4274	0.1452
R2	0.1129	0.1411	0.1895	0.4032	0.1532
R3	0.1129	0.1290	0.1573	0.4355	0.1653
R4	0.0887	0.1089	0.1169	0.3750	0.3105
R5	0.0847	0.0766	0.1331	0.4274	0.2782
R6	0.0403	0.1411	0.1492	0.3790	0.2903
R7	0.0887	0.1008	0.1815	0.3105	0.3185
R8	0.0645	0.0605	0.1613	0.4677	0.2460
R9	0.0605	0.0887	0.1694	0.4153	0.2661
R10	0.0927	0.0968	0.1492	0.4153	0.2460
R11	0.0847	0.0927	0.1532	0.4032	0.2661
R12	0.1331	0.1411	0.2742	0.3024	0.1492
R13	0.1734	0.1694	0.2460	0.2863	0.1250
R14	0.1371	0.1210	0.1815	0.3911	0.1694
R15	0.1169	0.1290	0.1653	0.4355	0.1532
R16	0.0887	0.0847	0.1411	0.4637	0.2218
R17	0.0806	0.1089	0.1855	0.4395	0.1855
R18	0.0887	0.1089	0.1573	0.3952	0.2500
R19	0.1331	0.0927	0.1653	0.3266	0.2823
R20	0.0927	0.0806	0.1129	0.3669	0.3468

After calculating similarity degrees, the maximum similarity degrees for each attribute among all states are

selected. Ranks are designated for the selected maximum values. Ranking is based maximum similarity degree among all states. The results of the selection of the maximum similarity degrees and results of ranking are shown in Table 4.

Table 3. The Values of similarity degree between fuzzy sets F and R

	F_1	F_2	F_3	F_4	F_5
R1	0.4777	0.4729	0.5076	0.5385	0.5291
R2	0.4789	0.4764	0.5110	0.5375	0.5297
R3	0.4744	0.4697	0.5041	0.5407	0.5351
R4	0.4658	0.4566	0.4885	0.5403	0.5736
R5	0.4602	0.4524	0.4910	0.5496	0.5702
R6	0.4615	0.4607	0.4979	0.5463	0.5684
R7	0.4694	0.4617	0.4964	0.5363	0.5705
R8	0.4539	0.4500	0.4960	0.5585	0.5645
R9	0.4591	0.4559	0.4988	0.5527	0.5666
R10	0.4661	0.4595	0.4969	0.5463	0.5588
R11	0.4643	0.4580	0.4962	0.5470	0.5645
R12	0.4902	0.4887	0.5228	0.5252	0.5195
R13	0.5040	0.4975	0.5190	0.5144	0.5098
R14	0.4819	0.4744	0.5067	0.5348	0.5330
R15	0.4756	0.4712	0.5058	0.5400	0.5317
R16	0.4613	0.4555	0.4957	0.5513	0.5550
R17	0.4659	0.4647	0.5071	0.5494	0.5431
R18	0.4680	0.4624	0.4990	0.5444	0.5583
R19	0.4776	0.4648	0.4951	0.5322	0.5600
R20	0.4621	0.4505	0.4832	0.5401	0.5849

Table 4. Maximum similarity degree and ranking

R	Maximum similarity degree for each state	Ranking	Linguistic values
R1	0.5385	6	satisfied
R2	0.5375	6	satisfied
R3	0.5407	5	satisfied
R4	0.5736	2	very satisfied
R5	0.5702	2	very satisfied
R6	0.5684	3	very satisfied
R7	0.5705	2	very satisfied
R8	0.5645	3	very satisfied
R9	0.5666	3	very satisfied
R10	0.5588	4	very satisfied
R11	0.5645	3	very satisfied
R12	0.5252	7	satisfied
R13	0.5190	8	neutral
R14	0.5348	6	satisfied
R15	0.5400	5	satisfied
R16	0.5550	4	very satisfied
R17	0.5494	5	satisfied
R18	0.5583	4	very satisfied
R19	0.5600	3	very satisfied
R20	0.5849	1	very satisfied

As can be seen in Table 4, the results are obtained with 5% neutral, 35% satisfied, and 60% very satisfied. As can be seen in Table 4, the 20-th state- achievement with 9% very dissatisfied, 6% dissatisfied, 11% neutral, 37% satisfied, and 35% very satisfied has a best rank. The states 4 (with 8.8% very dissatisfied, 11% dissatisfied, 11.7% neutral, 37.5% satisfied and 31.5% very satisfied), 5 (with 8.5% very dissatisfied, 7.7% dissatisfied, 13.3% neutral, 42.7% satisfied and 27.8% very satisfied) and 7 (with 8.9% very dissatisfied, 10% dissatisfied, 18.1% neutral, 31% satisfied and 32% very satisfied) are ranked as the second. The worst states are 13 (with 17.3% very dissatisfied, 17% dissatisfied, 24.5% neutral, 28.6% satisfied and 12.5% very satisfied), 12 (with 13.3% very dissatisfied, 14% dissatisfied, 27.5% neutral, 30.2% satisfied and 15% very satisfied), 14 (with 13.7% very dissatisfied, 12.1% dissatisfied, 28.1% neutral, 39% satisfied and 17% very satisfied), 2 (with 11.3% very dissatisfied, 14.1% dissatisfied, 19% neutral, 40.3% satisfied and 15.3% very satisfied) and 1 (with 12.5% very dissatisfied, 12.5% dissatisfied, 17.7% neutral, 42.7.2% satisfied and 14.5% very satisfied). Since input parameters of model are fuzzy variables, output of proposed model (rankings) would be fuzzy

We apply a method of non-parametrical correlation to measure the statistical relation of ranks of alternatives[21,22]. Comparisons of the approaches are based on Spearman's rank correlation test. Spearman's rank correlation coefficient can be used to represent the degree of dependence between two variables. It is calculated from the ranks provided with every pair of the applied methods. Spearman's rank correlation coefficient r_s can be calculated applying the following equation[21]:

The paper[23] used Spearman's rank correlation to compare the ranks achieved by multiple criteria decision making methods. Using (4) and (5) Z statistics is calculated and compared with the predefined Z value in[24]. If the calculated test statistics are larger than 1,645 then the null hypothesis is rejected. Here the null hypothesis corresponds to "There is no similarity between two rankings", where the alternative hypothesis is "Two rankings are similar".

The values of Z between Turkse-Wilson's and Wang's methods and also between Turksen_Wilson's and Biswas's methods are calculated as 4.2540 and 4.1688 correspondingly. These values are greater than 1.645, which indicates that the null hypothesis is rejected and the difference in ranking results is statistically insignificant. From the above discussion, it can be obtained that the ranking of the satisfaction of hotel employees using Turksen-Willson's method are reliable and results can be used by the managers.

Table 5. Maximum similarity degree and ranking using Wang's approach

R	Maximum similarity degree for each state	Ranking	Linguistic values
R1	0.7400	6	very satisfied
R2	0.7384	7	very satisfied
R3	0.7432	6	very satisfied
R4	0.7610	4	very satisfied
R5	0.7755	3	very satisfied
R6	0.7674	4	very satisfied
R7	0.7642	4	very satisfied
R8	0.7900	1	very satisfied
R9	0.7803	2	very satisfied
R10	0.7642	4	very satisfied
R11	0.7690	4	very satisfied
R12	0.7006	8	very satisfied
R13	0.6845	9	very satisfied
R14	0.7368	7	very satisfied
R15	0.7416	6	very satisfied
R16	0.7706	3	very satisfied
R17	0.7642	4	very satisfied
R18	0.7610	4	very satisfied
R19	0.7497	5	very satisfied
R20	0.7706	3	very satisfied

Table 6. Maximum similarity degree and ranking using Biswas's approach.

R	Maximum similarity degree for each state	Ranking	Linguistic values
R1	0.3670	7	satisfied
R2	0.3620	7	satisfied
R3	0.3721	6	satisfied
R4	0.3992	4	very satisfied
R5	0.4009	3	very satisfied
R6	0.3911	4	very satisfied
R7	0.3865	5	very satisfied
R8	0.4115	2	satisfied
R9	0.3945	4	satisfied
R10	0.3817	5	satisfied
R11	0.3848	5	very satisfied
R12	0.3322	9	satisfied
R13	0.3217	10	neutral
R14	0.3556	8	satisfied
R15	0.3707	6	satisfied
R16	0.3968	4	satisfied
R17	0.3886	5	satisfied
R18	0.3757	6	satisfied
R19	0.3652	7	very satisfied
R20	0.4211	1	very satisfied

Table 7. Comparisons of Turksen_Wilson's, Wang's and Biswas's methods

	Traditional		Wang's method	Biswas's method	Turksen_ Wilson's method	Differences	
R	Mean	Standard Deviation	Ranking	Ranking	Ranking	Turksen_Wilson's & Wang's	Turksen_Wilson's & Biswas's
R1	3.3427	1.6269	6	7	6	0	-1
R2	3.3427	1.6269	7	7	6	-1	-1
R3	3.4113	1.6466	6	6	5	-1	-1
R4	3.7097	1.7691	4	4	2	-2	-2
R5	3.7379	1.7834	3	3	2	-1	-1
R6	3.7379	1.7834	4	4	3	-1	-1
R7	3.6694	1.7493	4	5	2	-2	-3
R8	3.7702	1.8004	1	2	3	2	1
R9	3.7379	1.7834	2	4	3	1	-1
R10	3.6250	1.7287	4	5	4	0	-1
R11	3.6734	1.7512	4	5	3	-1	-2
R12	3.1935	1.5959	8	9	7	-1	-2
R13	3.0202	1.5813	9	10	8	-1	-2
R14	3.3347	1.6248	7	8	6	-1	-2
R15	3.3790	1.6369	6	6	5	-1	-1
R16	3.6452	1.7379	3	4	4	1	0
R17	3.5403	1.6926	4	5	5	1	0
R18	3.6089	1.7215	4	6	4	0	-2
R19	3.5323	1.6894	5	7	3	-2	-4
R20	3.7944	1.8135	3	1	1	-2	0
					r_s	0.9759	0.9564

$$r_s = 1 - \frac{6\sum_{i=1}^{n} d_i^2}{n(n^2-1)} \tag{4}$$

$$Z = r_s\sqrt{n-1} \tag{5}$$

4. Conclusions

In this paper, the integration of fuzzy logic and conjoint analysis is used for evaluation of the job satisfaction of hotel employees. The solution of the problem is based on data collection and analysis of fuzzy preferences of employees. Respondents and experts have stated their opinions about each attribute, and these opinions are used for measuring of job satisfaction. Using preference levels the similarity measure between employees' opinions and experts' opinions are determined. These similarity measures are used for evaluation of job satisfaction of the hotel's employees. The experimental results have been obtained using the opinions of employees of different hotels of North Cyprus. The Turksen-Wilson's method is applied to job satisfaction of the hotel employees. It has been found that 20-th achievement attribute with 9% very dissatisfied, 6% dissatisfied, 11% neutral, 37% satisfied, and 35% very satisfied has the best rank. The states 4, 5 and 7 are ranked as the second. For comparative analysis, the same problem is simulated with Wang's and Biswas's methods also. Using Wang's method the state 8-th state is ranked as first, the state 9 is ranked as second. Using Biswas's method the state 20-th state is ranked as first, and the states 8 and 5 are ranked as second. Based on the simulation results, it can be obtained that the ranking of job satisfaction states using Turksen and Willson's method are reliable and results can be used by the hotel managers. Results obtained from the fuzzy conjoint analysis can be used as an alternative method for analysing job satisfaction.

Appendix A.

The Minnesota Satisfaction Questionnaire

N^0	Questions	Facets
Item1	Being able to keep busy all the time	Activity
Item2	The chance to work alone on the job	Independence
Item 3	The chance to do different things from time to ti	Variety
Item 4	The chance to be somebody in the community	Social Status
Item 5	The way my boss handles his/her workers	Supervision / human relations
Item 6	The competence of my supervisor in making decisions	Supervision/ technical
Item 7	Being able to do things that don't go against my conscience	Moral values
Item 8	The way my job provides for steady employment	Security
Item 9	The chance to do things for other people	Social Service
Item 10	The chance to tell people what to do	Authority
Item 11	The chance to do something that makes use of my abilities	Ability
Item 12	The way company policies are put into practice	Policies and practices
Item 13	My pay and the amount of work I do	Compensation
Item 14	The chances for advancement on this job	Advancement
Item 15	The freedom to use my own judgment	Responsibility
Item 16	The chance to try my own methods of doing the job	Creativity
Item 17	The working conditions	Work Conditions
Item 18	The way my coworkers get along with each other	Co- workers
Item 19	The praise I get for doing a good job	Recognition
Item 20	The feeling of accomplishment I get from the job	Achievement

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